PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P06477PC00	FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/EP2004/014668	International filing date *(day/month/year)* 23.12.2004		Priority date *(day/month/year)* 30.12.2003

International Patent Classification (IPC) or national classification and IPC

H04L12/56

Applicant

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1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

   a. ☒ *sent to the applicant and to the International Bureau)* a total of 4 sheets, as follows:

      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

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4. This report contains indications relating to the following items:

   ☒ Box No. I   Basis of the opinion

   ☐ Box No. II   Priority

   ☐ Box No. III   Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   ☐ Box No. IV   Lack of unity of invention

   ☒ Box No. V   Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   ☐ Box No. VI   Certain documents cited

   ☐ Box No. VII   Certain defects in the international application

   ☐ Box No. VIII   Certain observations on the international application

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Date of submission of the demand 28.10.2005	Date of completion of this report 05.12.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Müller, N Telephone No. +49 89 2399-7144

INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY

International application No.
PCT/EP2004/014668

AP20 Rec'd PCT/PTO 12 JUL 2006

Box No. I   Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐   This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

    ☐ international search (under Rules 12.3 and 23.1(b))
    ☐ publication of the international application (under Rule 12.4)
    ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-15   as originally filed
4b   filed with the demand

Claims, Numbers

1-14   filed with the demand

Drawings, Sheets

1/4-4/4   as originally filed

☐   a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☒   The amendments have resulted in the cancellation of:
    ☐ the description, pages
    ☒ the claims, Nos. 15-30
    ☐ the drawings, sheets/figs
    ☐ the sequence listing *(specify)*:
    ☐ any table(s) related to sequence listing *(specify)*:

4. ☐   This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
    ☐ the description, pages
    ☐ the claims, Nos.
    ☐ the drawings, sheets/figs
    ☐ the sequence listing *(specify)*:
    ☐ any table(s) related to sequence listing *(specify)*:

*   *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V   Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-14
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-14
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-14
	No:	Claims	

2. Citations and explanations (Rule 70.7):

   see separate sheet

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

Re Item V
**Reasoned statement with regard to novelty, inventive step or industrial
applicability; citations and explanations supporting such statement**

The present invention relates to a method (**claim 1**) for adjusting the beacon rate in an ad
hoc or multihop network, and the corresponding radio node (**claim 10**) and system (**claim
14**).

According to document **D1 = WO 01/92992**, which represents the closest prior art, an ad
hoc radio node adjusts its beacon rate based on network dynamics in order to permit other
nodes in the network to detect the node more quickly if the network changes fast (eg.
when the node moves fast). However, according to D1, the network dynamics, ie. the
movement of the node, is detected based on either the internal measurement of the node's
physical speed or changes in the wireless connectivity with nearby neighbour nodes.

These two prior art solutions for determining the network dynamics have the following
drawbacks: either the node has to be supplied with a speed determination equipment, or
the node has to maintain a database of wireless connectivity with nearby neighbour nodes.
Therefore, the problem to be solved by the present invention is to decrease the complexity
of the node when determining the network dynamics.

According to the present invention, the node receives the beacons transmitted from other
nodes. From said beacons, the node determines the **relative speed** of each other node
relative to itself. The network dynamics are determined based on said determined relative
speed values. Thereby, the node may adjust its beacon rate only by receiving and
processing other beacon messages.

Claim 1 is therefore novel and considered to involve the required inventive step, Articles
33 (2) (3) PCT. The subject-matter of claim 1 is also industrially applicable.

The same applies to **independent claims 10 and 14**, which contain the same feature
combination as claim 1 in terms of claims relating to a radio node and a system. Said
claims, therefore, equally meet all the requirements of Article 33 PCT.

Dependent claims 2 to 9 and 11 to 13 relate to further implementing details of the method defined by claim 1, or the node of claim 10, respectively, to which they refer and are thus equally novel, inventive and industrially applicable.

Further Remarks

The feature "the relative speed of the radio nodes in the subset" in **claim 1** and "relative speed of each of the other nodes" in **claim 10** is not clear (Article 6 PCT) for the reason that in the description (see page 9, lines 16 to 17) and claim 11 the relative speed of the (neighbour) node is a relative speed of the (neighbour) radio node **compared to the first radio node.** It is noted that the feature "the relative speed of the radio nodes", as used in present claim 1, could be misinterpreted as "relative speed between (neighbour) radio nodes", which has no support in the original application documents.

Furthermore, it is clear from the description (see in particular page 4, lines 25 to 26) that the feature "adjusting the beacon rate **based on the estimate of the network dynamics"** is essential to the definition of the invention. Since **independent claim 10** does not contain said feature, said claim does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

The expression "the radio nodes of the system **uses the beacon transmitting method** according to any of the claims 1 to 9" used in **independent claim 14** is vague and unclear, because it does not express that the concerned radio nodes *"comprise means being adapted/arranged to perform the method steps of any of claims 1 to 9"* but only that they are able, when being programmed or otherwise modified, to perform said method steps. Hence, said claim does not meet the requirements of Article 6 PCT.

The feature "...**the** first radio node ..." in **claim 11** is not clear, see Article 6 PCT, since said feature has not been previously defined in said claim or in any claim on which said claim depends, ie. there is no antecedent for said feature.

The vague and imprecise statement in the description on page 15, line 10 ("...**spirit and scope...**") implies that the subject-matter for which protection is sought may be different to

that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them.

CLAIMS:

1.   A method in a radio node (205), the first radio node, of transmitting beacon messages to at least a second radio node in an ad hoc or multihop network, wherein the ad hoc or multihop network comprises a plurality of further radio nodes (205, 215), wherein the rate of which the radio node transmits its beacons is adaptive, the method in the first radio node **characterised by** the steps of

a) *-defining* a subset, NB_y, of neighbours (305);

b) *-recording* a plurality of beacon message (310) from the radio nodes which are part of the subset, and determining the relative speed of the radio nodes in the subset from the recorded respective plurality of beacon messages;

c) *-estimating* the network dynamics (315), based on the relative speed of the radio nodes in the subset;

d) *-determining* beacon rate (325), based on the estimate of the network dynamics.

2.   Beacon transmitting method according to claim 1, **wherein** the beacon transmit power at which the first radio node radio transmits its beacons is based on the estimate of the network dynamics.

3.   Beacon transmitting method according to claim 1 or 2, **wherein** the estimate of the network dynamics is based on analysis of the relative speed of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

4.   Beacon transmitting method according to any of claims 1 to 3, **wherein** the method comprises a step, to be performed prior to the determining step d), of:
-comparing estimates of network dynamics (320), wherein if the current estimate of network dynamics differ with at least a predetermined amount from a previous estimate of the network dynamics, the method proceeds to the determining step d), and otherwise the first the method continues to monitor the neighbouring radio nodes in the subset (steps a-c).

5.   Beacon transmitting method according to any of claims 1 to 4, **wherein** the step of estimating the network dynamics, the estimate of the network dynamics is at least partly based on the path loss history of the beacons received from the radio nodes in the subset.

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6. Beacon transmitting method according to any of claims 1 to 5, **further comprising** a step of *storing* beacon parameters of the respective beacon messages.

7. Beacon transmitting method according to claim 7, **wherein** the beacon parameters comprise at least one parameter relating to received signal strength of the beacon message, and at least one parameter relating to time of arrival of the beacon messages.

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8. Beacon transmitting method according to claim 6 or 7, **wherein**, the beacon parameters comprise parameters that have been included by the sending radio node in the beacon message.

10 9. Beacon transmitting method according to claim 8, **wherein**, at least one parameter originally included by the sending radio node comprises a parameters relating to the position of the sending node.

10. A radio node (205) adapted for communication in an ad hoc or multihop network, the radio node comprising and a transmitting part adapted to transmit beacon messages and a receiving part adapted to receive beacon messages, the radio node

15 **characterized by**

-beacon recording means (505) for recording a plurality of beacon messages from a plurality of other radio nodes, and determining beacon parameters, the received beacon parameters comprising at least the respective received signal power and time of arrival of the received beacon messages;

20 -storing means (510) for storing the received beacon parameters;

-statistical processing means (515) for performing a statistical analysis on the stored plurality of beacon parameters, whereby producing an estimate of the network dynamics based on relative speed of each of the other radio nodes;

-beacon adjusting means (520) for adjusting the transmission rate and/or power of

25 transmitted beacon messages.

11. Radio node according to claim 10, **wherein** the statistical processing means (515) estimates the network dynamics at least partly based on analysis of the relative speed of the at least one other radio node compared to the first radio node.

30 12. Radio node according to claim 11, **wherein** the statistical processing means (515) estimates the network dynamics at least partly based on analysis of the relative speed

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of a plurality of neighbouring radio nodes and wherein the neighbouring radio node that exhibit the highest relative speed compared to the first radio node, is given the greatest impact on the estimate of the network dynamics.

13. Radio node according to any of claims 10 to 12, **wherein** the beacon receiving means (505) is adapted to define a subset, NB_v, of neighbouring radio nodes, and the storing means (510) is adapted to record and store received beacon parameters from at least a second radio node which is part of the subset.

14. A system of a plurality of radio nodes (205, 215) adapted to communicate in an ad hoc or multihop network, wherein the radio nodes (205, 215) transmits beacon messages (HELLO messages) between each other, the system **characterised in** that the radio nodes (205, 215) of the system uses the beacon transmitting method according to any of the claims 1 to 9.

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WO 01/92992 and WO 01/73959 teach methods of a radio node, or router, transmitting beacon messages to other radio nodes in a network. The rate of which the node/router transmits its beacons is adaptive. The rate is determined from for example physical speed, the change in wireless connectivity with nearby neighbour nodes or expected plans for further

5   movement. The rate may further be influenced by the start up conditions of the node/router. The physical speed, which only referrers to the speed of node/router in question, can be determined from for example positioning tools or by monitoring the rate of change of nearby nodes over time.